# POSSIBILITIES AND METHODS OF INVESTIGATION OF FOSSIL RIVER BEDS

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РЕЗЮМЕ

В системе добычи воды с береговой фильтрацией часто необходима точная локализация заполненных в недавнем геологическом прошлом русел рек, поскольку качество воды в таких местах существенно портится. Локализация положеиня русел может быть проведена с помощью следующих методов:

*а)* бурение по густой сетке
*б)* измерение геоэлектрuческого сопротивления
*в)* использование страрых карт
*г)* интерпретация крупномасштабных карт нивелирования
*д)* химический анализ воды
*е)* непосредственное исследование района при высоком уровне воды в реках и грунтовых вод
*ж)* детальный анализ растительности
*з)* исследование карт положения покрывающих слоев гравия
*и)* интерпретация данных аэрофотос'емок

В работе показана эффективность применения отдельных методов на примере исследования района острова Чепель, где были применены все вышеуказанные методы за исключением аэрофотос'емки.

## Introduction

In the course of changes of the river bed the branches turned inactive will be disjoined and they will be filled by sediments becoming more and more fine grained going upwards from below. In the fine grained sediments much organic matter is contained, the anaerobic disintegration of which results in a reductive environment. As a consequence of this the oxigen content solved in the surrounding ground water falls below 20%, where the $Fe^{2+}$ and $Mn^{2+}$ ions go into solution.

It is therefore important to know precisely the places of the fossil river beds, as well as the spontaneous flow of the ground water, so that we could draw conclusion to the flow presenting itself on the occasion of a later water extraction.

Several investigation methods concerning the places of fossil river beds were studied by us on the Western side of Csepel-island and we will give here an evaluation of the methods, the possibilities and limits of their application.

The disjoined beds of the investigated area are not the disjointed mort-lakes of a meandering river, but they are the consequences of a slow flanking erosion from western direction and of the bed changes caused by floods, therefore they are mostly characteristically straight or their radii of curvature are very great.

## Various methods of investigation of fossil river beds

These are:

*a)* By means of borings taking core-samples in a dense network one can get a very precise picture of the positions of one time beds, but the application of this method is very restricted owing to its expensivity of time and costs. It can be applied on a restricted area in the narrow surroundings of the planned water-producing project; furthermore it is practical to set up these in the early phase of the study – taking into account the traces found at the surface – for the detection of local features of the buried river beds. The basic dimension-parameter of the network can not surpasse the river width to be expected, because the borings made in a sparse net provides ill-proportionately less information, their results depend on chance and it may happen that we get a misleading paleogeographical picture.

*b)* On an area with known layering we can state the places of fossil river beds in general with a relatively high reliability by means of geo-electric resitivity measurements. The electric resistivity of the surrounding terrace gravel is 200 – 1000 ohmm, that of the silt filling the bed is 10 – 100 ohmm, so that the basic conditions of the resistivity mesurements are fulfilled. It may be disturbing that the smaller beds are not becoming deeply immersed into the gravel body, so that in every case one had to carry out a complete vertical electric sounding down to the depth of the impermeable substratum. A trouble difficult to be overcome is the circumstance, if the local ground water level coincides with the lower boundary of the list filling the bed. A further difficulty is that the wide bed at places can not be measured out with one central point, because the $\frac{\overline{AB}}{3}$ belonging to the $\overline{AB}$ max. equalling the bed width can surpasse by several times the depth of the impermeable substratum. In such a case it is practicable to carry out – besides the verical sounding – also a horizontal profiling and to chose the size of $\overline{AB}$ three times as long as the depth of the bottom layer. All these refer to a symmetrical Schlumberger electrode configuration.

*c)* Using old maps one can sometimes fix the state existing before the major human intervention (regulation of the bed), respectively one can state the natural changes from the oldest existing map (1528) up to the regulation of the bed (1850) from time to time and to clear the regularities of the variations.

Restrictions of the use of old maps are as follows: The changes of the river beds are recognisable only in broad lines, but the maps are not suitable – without other features – for the exact recognition of the past of limited areas. The cause of this lies – besides the inaccuracies of the one time surveys – in the scale and projection of the map. The scale is very small, it is not a decimal number (1 : 1440; 2880)

and it is not given explicitely in the text, and it is rarely given even graphically. The projection is very rarely given by a net and hardly mentioned in references, so that it is impossible to redraw the maps in Gauss-Krüger or stereographic projection. Thus, the ancient map is a good orientating tool for the character of the variations, but for an actual practical purpose it is only suitable together with other complementing factors.

As an example of what was said above we may mention the situation of the small islands in the branches of the Danube around the Csepel-island. In the main branch the islands did not change their position during the last 400 years (except for smaller sandbanks), only the river branches around them changed (the Háros–, Ercsi– and Rácalmás islands), while in the eastern (Ráckeve) branch – despite of the lower water transport – we encounter a vivid development, discontinuing and wandering of islands. Two major islands (Angyali and Kerek-sand bank) did not exist at all at the beginning of the XVIIIth century.

Another informative example is the case of the connection between the two branches of the Danube. On the map of Marsigli (1726) many complicated flowings through can be seen in SW direction from the Ráckeve-branch into the main branch. On the present contour maps of the gravel cover the beds show – owing to the isohypses constructed on the basis of insufficient data – just a reversed connection. Thus, using the Marsigli-map we succeeded to detect the real character of a phenomenon, while the modern, sketchy surveys were successful in determining, its exact spot.

*d)* Through the evaluation of large scale contour maps we are able to get useful data only on areas not having undergone topographic regularization and agricultural cultivation. This condition has been fulfilled in our case, because in the course of location of the dam trace in the last century they tried to leave the fossil beds on the flood area.

On the given length-profile we selected the contour line corresponding to the height above sea level of the highest water level and we carried out the marking off of the areas lower than this one, then for sake of checking we repeated the procedure using a contour level value lower by 1 and 2 meters: the basic bed picture has not changed in these cases. But the fixing of the local highest water level is not fully exact owing to the great distances of the water – gauges, nevertheless, if we take into account that on the given section of the Danube its mean fall is 7 cm/km and the contour lines follow each other with a height difference of 1 m, we can be sure that the error made by linear interpolation can not be too high.

*e)* By a local perambulation we can make more precise the picture assured by the contour map first of all in the case of a very high water level. In that case, namely, the fossil river beds will also be filled with water owing to the rule of the communicating vessels and such minute

depression of a few dm depth can be observed, which do not appear clearly on the contour map of 1 m line distance and also the local high water level can be observed with an unambiguous accuracy.
According to the observations of earlier years the water movement in the fossil beds follows the Danube level with a lag of 2–4 days, but it appears in all beds at the same time, independently of the distance from the Danube. According to our interpretation this indicates that the delay is not caused by the resistance of the communicating layers, but first of all by the bed-resistance of the Danube.
But because only the 1–2 days of the culmination can be used for such perambulation of the terrain, the method can serve only to make the picture obtained by the contour map more accurate and to clear some problematic data.

*f)* Water-chemical investigations may be expedient first of all on areas, where many old digged or bored wells are at disposal for taking water samples, but owing to their ancient structure the layering is not known. It is an experienced fact – it can be deducted also theoretically – that the silt of high organic content filling the fossil beds exhausts the solved oxigen-content of the water. The oxigen solved in water can be measured also directly, but it is advisable before the measurement to carry out a cleaning pumping and to make the measurement by means of an electrode which can be lowered into the well. We can draw an indirect conclusion to the presence of the fossil bed of its high mobile iron and manganese content too.
In case of water-chemical investigations we have also to take into account the direction and speed of a possible ground water flow; furthermore we have to consider that the waters of iron or manganese content can reach at a long distance by diffusion too. On the area under investigation is – according to our measurements – the ground water flow to be neglected, but the effect of diffusion is present.
A further important point of view is that during a measurement series no temperature differences during the time should be present, because these can alter in itself the oxigen content solved in the water.

*g)* We can obtain many useful informations also by a detailed evaluation of the biomass-production of the vegetation. The nutritive material content of the silt filling the bed is significantly greater, than that of the surrounding gravel and also its water household is better.
But it is very difficult to draw conclusions to the biomass-production – decomposed to small areal units – from forestry data, because the production data are averaging ones valid for larger territories, and the quantity of the biomass depends – besides the characteristics of the production area-largely also on the species of trees and on the cultivational methods.
According to our experience, however, a very good orientation can be obtained from the circumstance that the willow (Salix) can regenerate its wickers cut for osier culture from year to year i. e. the willow

wickers can be regularly exploited only over the fossil beds . This is an apparent phenomenon, which can be observed through a great distance.

*h)* From contour maps of the gravel covering (or substratum) we can get data for the area between the borings and openings by interpolation. But contour map can be constructed without ambiguity only in the possession of a sufficiently dense data network. We mentioned already the danger resulting from a conclusion drawn from insufficient data material on the occasion of the Marsigli map, which can lead to a picture contrasting the reality.

But, considering the fact that the surface of the gravel can be observed more simply and inexpensively, than other data of the layer series, therefore the contour map of the gravel covering possesses a high significance, if the fossil bed is to some extent immerged into a gravel body.

*i)* By the interpretation of aerial photos it is possible to detect buried river beds with great accuracy and reliability first of all on uncovered agricultural areas. On areas similar to that investigated by us, which have been afforested and intensively subjected to forestry cultivation, the simple aerial photo does not give much information.

## Conclusions

For the accurate recognition of fossil beds having high organic material content and spoiling water quality several methods are at disposal, assuring different reliability and accuracy. Local conditions may decide, which of then can be applied; according to our opinion the more methods will be used in a harmony one with another, in a complex manner, the more we get a complete picture. When using several methods it is not the plurality principle that decides, whether on a given spot there was or not a river bed, but we have to accept the positive result of any method, if it is not in contradiction to our experiences. The idealized picture, namely, as outlined above does not furnish – owing to causes not to be detailed here – unequivocal result in every case. E. g. morphological elements and vegetation are not in contradiction one with another, but it happens frequently that they present themselves separately, owing to the human activity. At places an unsuccessful attempt of plant cultivation disrupted the original vegetation, on other spots, though the depressions have been filled out, the roots of the plants go down into the water and only a vegetation enduring these conditions can hold out permanently. The trials of several methods known well before as well as their coordination were carried out by us on the west-side of the Csepel-island on a flood area of 30 km$^2$. By the condensation of observations made at points we succeeded to make more precise the paleogeographical picture of the area, but all the methods can be extended to the east-side of the island, to the Ráckeve- branch of the Danube, where the higher urbanisation conceals to a greater extent the original state.

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